prime_exponent_dataset

March 29, 2025

[7]:
```python
import random
import math
import pandas as pd
from sympy import primerange
```

[9]:
```python
def generate_exponent_vectors(n_vectors, vector_len, exponent_range=(0, 4)):
    vectors = []
    for _ in range(n_vectors):
        vector = [random.randint(*exponent_range) for _ in range(vector_len)]
        vectors.append(vector)
    return vectors

def vector_to_integer(vector, primes):
    result = 1
    for exponent, prime in zip(vector, primes):
        if exponent != 0:
            result *= prime ** exponent
    return result

def build_dataset(n_vectors=1000, vector_len=50, exponent_range=(0, 4),␣
 ↪include_log=True):
    primes = list(primerange(0, 1000))[:vector_len]
    vectors = generate_exponent_vectors(n_vectors, vector_len, exponent_range)

    rows = []
    for vec in vectors:
        n = vector_to_integer(vec, primes)
        row = vec + [n]
        if include_log:
            row.append(math.log(n))
        rows.append(row)

    columns = [f"e{i}" for i in range(vector_len)] + ["integer"]
    if include_log:
        columns.append("log_integer")

    df = pd.DataFrame(rows, columns=columns)
    return df

# Customize your dataset size and range here
n_vectors = 5000
vector_len = 50
exponent_range = (0, 4)

# Build the dataset
df = build_dataset(n_vectors, vector_len, exponent_range, include_log=True)
df.head()
```

```
[9]:    e0  e1  e2  e3  e4  e5  e6  e7  e8  e9  …  e42  e43  e44  e45  e46  e47  \
     0   1   0   0   1   0   2   3   0   0   4  …    0    4    4    0    0    4
     1   3   4   2   4   2   0   3   0   0   2  …    0    1    0    3    1    4
     2   3   4   3   3   1   4   0   0   3   2  …    2    1    1    3    4    4
     3   0   2   2   2   4   4   0   3   1   1  …    1    2    3    3    2    4
     4   0   4   1   0   1   4   0   1   4   2  …    3    0    2    1    2    1

        e48  e49                                            integer  log_integer
     0    3    4  8589166514947611412816377907849854651078739604…   448.852010
     1    3    2  1904612167355784301832824375696105218063354648…   412.807010
     2    2    1  6116043932951435027909852094134890525986125010…   483.051200
     3    4    1  1308839492205756159555290445116798089379976127…   389.406022
     4    0    0  2622885573510356974742817620930005478022352491…   410.824422

     [5 rows x 52 columns]
```

```
[6]: # Customize the dataset size and range here
n_vectors = 5000
vector_len = 50
exponent_range = (0, 4)

# Build the dataset
df = build_dataset(n_vectors, vector_len, exponent_range, include_log=True)
df.head()
```

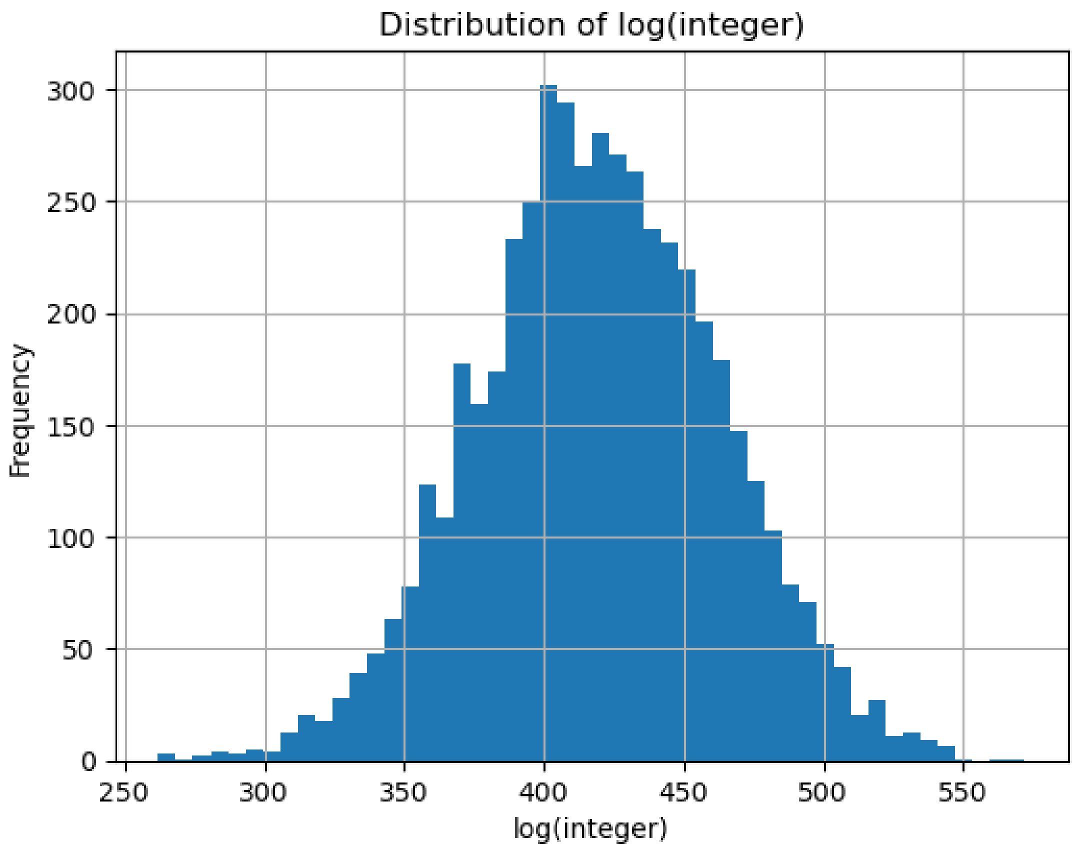
```
[6]:    e0  e1  e2  e3  e4  e5  e6  e7  e8  e9  …  e42  e43  e44  e45  e46  e47  \
     0   0   4   2   2   1   1   0   1   2   1  …    0    0    4    1    1    1
     1   2   4   0   0   1   2   0   4   0   3  …    2    0    2    1    1    1
     2   1   1   0   0   1   4   2   4   2   0  …    4    2    3    4    2    4
     3   4   0   2   1   1   0   1   0   2   1  …    1    4    0    1    1    1
     4   0   3   4   2   0   2   0   1   0   1  …    1    0    3    2    0    1

        e48  e49                                            integer  log_integer
     0    0    2  13342939937542444237914801235838452661115369047…   375.609772
     1    1    3  3594655179403018628885998736194101473663523195…   339.759457
     2    3    0  1028901819526017672241536577491951006573496116…   478.966191
```

```
3     1     2   4593454237727214546518752165241945277689569918…   395.266683
4     2     4   4833710362604610384437010923738843349472238186…   383.804740

[5 rows x 52 columns]
```

[10]:
```python
df.to_csv("prime_exponent_dataset.csv", index=False)
print("Dataset saved to prime_exponent_dataset.csv")
```

```
Dataset saved to prime_exponent_dataset.csv
```

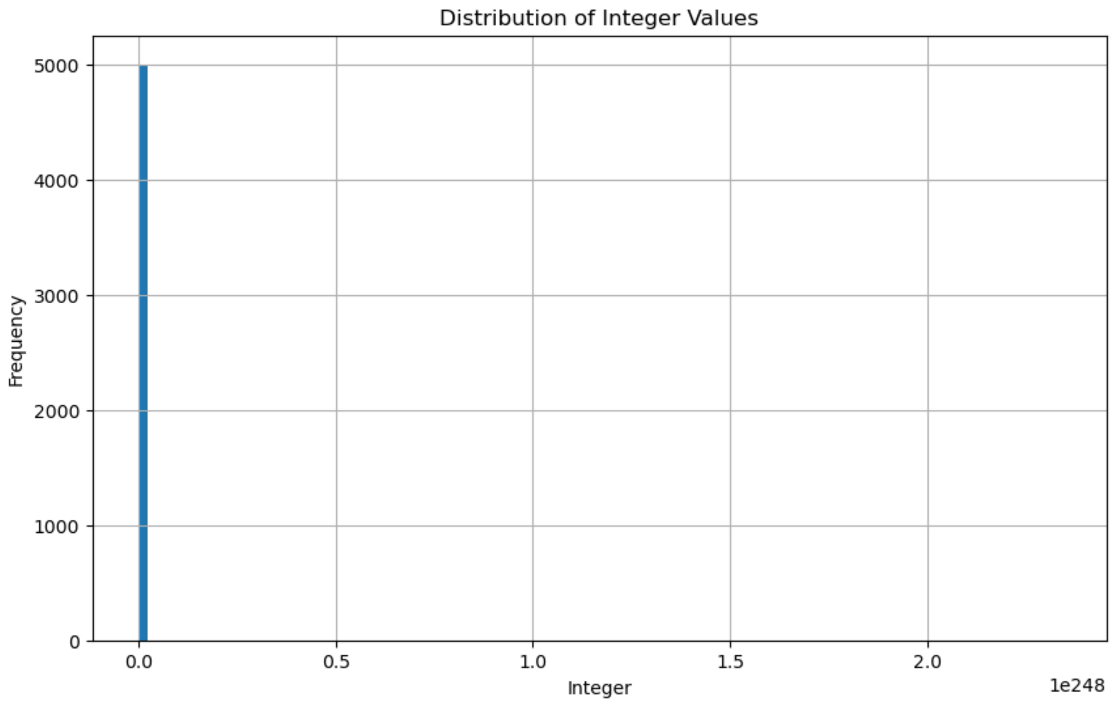
[12]:
```python
import matplotlib.pyplot as plt

plt.hist(df["log_integer"], bins=50)
plt.title("Distribution of log(integer)")
plt.xlabel("log(integer)")
plt.ylabel("Frequency")
plt.grid(True)
plt.show()
```



[13]:
```
# Count how many integers are repeated in the dataset
n_unique = df["integer"].nunique()
n_total = len(df)

print(f"Unique integers: {n_unique} out of {n_total}")
print(f"Number of repeated integers: {n_total - n_unique}")
```

```
Unique integers: 5000 out of 5000
Number of repeated integers: 0
```

[15]:
```
import matplotlib.pyplot as plt
df["integer"] = pd.to_numeric(df["integer"])

plt.figure(figsize=(10, 6))
plt.hist(df["integer"], bins=100)
plt.title("Distribution of Integer Values")
plt.xlabel("Integer")
plt.ylabel("Frequency")
plt.grid(True)
plt.show()
```



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